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# Analysis of anaerobic blood cultures in burned patients<sup>☆</sup>

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## ABSTRACT

The utility of anaerobic blood culturing is often debated in the general population, but there is limited data on the modern incidence, microbiology, and utility of obtaining routine anaerobic blood cultures for burned patients. We performed a retrospective review of the burned patients electronic medical records database for all blood cultures drawn between January 1997 and September 2005. We assessed blood cultures for positivity, organisms identified, and growth in aerobic or anaerobic media. 85,103 blood culture sets were drawn, with 4059 sets from burned patients. Three hundred and forty-five single species events (619 total blood culture isolates) were noted in 240 burned patients. For burned patients, four isolates were obligate anaerobic bacteria (all *Propionibacterium acnes*). Anaerobic versus aerobic culture growth was recorded in 310 of 619 (50.1%) burned patient blood culture sets. 46 (13.5%) of the identified organisms, most of which were not obligate anaerobic bacteria, were identified from solely anaerobic media. The results of our study suggest that the detection of significant anaerobic bacteremia in burned patients is very rare and that anaerobic bottles are not needed in this population for that indication. However anaerobic blood cultures systems are also able to detect facultative and obligate aerobic bacteria; therefore, the deletion of the anaerobic culture medium may have deleterious clinical impact.

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## 1. Introduction

The presence of anaerobic bacteremia has steadily declined over the past several decades, reported in the 1970s as high as 25% of all bacteremias, to a present rate of less than 5% [1–3]. Although the overall incidence of anaerobic bacteremia is low, the mortality of untreated infection remains high, between 27% and 55% [1–7]. Although it is still common medical practice to draw both aerobic and anaerobic blood cultures for patients with known or suspected infection, there is debate about the utility of such practice. Some authors cite a low incidence of anaerobic bacteremia, easily anticipated

settings for anaerobic infection, and lack of improved survival with use of anaerobic culture as reasons against routine anaerobic blood cultures [8–12]. Others advocate routine use of anaerobic blood cultures, emphasizing an inability to reliably predict anaerobic bacteremia and a high mortality associated with these infections [3–5,13,14]. In addition, anaerobic culture systems can detect facultative and obligate aerobic bacteria potentially increasing the recovery of bacteria.

Although the utility of anaerobic blood culturing has been explored thoroughly in the general population, to our knowledge, there is scant data on the modern incidence,

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microbiology, and utility of obtaining routine anaerobic blood cultures for burned patients. Burn wounds are an important source of bacteremia, and anaerobic bacteria have been noted in or on burn wounds. However, the incidence among studies that mention anaerobes varies greatly, between 0.6% and 66% [7,15-21]. An analysis of anaerobic bacteremia in burned patients may provide a basis for or against the selective use of anaerobic blood cultures in this cohort.

## 2. Methods

After institutional review board approval, a retrospective chart review was performed in a 40-bed burn center at a 224 bed level I trauma center that serves both the Department of Defense and local civilian populations. We reviewed electronic records between January 1997 and September 2005, for all blood cultures drawn at our facility and submitted to the hospital microbiology department. For burn patients, blood culture isolate, growth in aerobic and/or anaerobic bottle (s), age, sex, and percent burn (TBSA) were evaluated. The BACTEC™ (Becton, Dickinson and Company, Franklin Lakes, NJ, USA) blood culture system was utilized prior to 2002, and the BacT/Alert® (bioMérieux, Durham, NC, USA) afterwards. Bacteria were identified by Vitek® (bioMérieux, Durham, NC, USA). Blood cultures were obtained via central venous catheters, arterial lines, or peripheral phlebotomy.

Burn patient care consisted of resuscitation and stabilization on arrival with early wound excision and skin grafting. Standard perioperative antibiotics consisted of vancomycin and amikacin administered on the day of surgery. Topical

antimicrobial creams were applied during their hospitalization, the nature of which varied by attending staff. Patients were cared for in individual rooms with contact isolation and hygiene protocols in practice.

Patient demographics were presented as simple means and standard deviations. Blood culture data was presented as totals and percentages.

## 3. Results

Blood culture sets were drawn, with 4,059 blood culture sets drawn from burned patients. 80.0% of burned patients admitted during the study period were men, had a mean age of  $33.6 \pm 18.6$  years, and a mean burn TBSA of  $13.1 \pm 16.5\%$ . A single species event was defined as bacteremia with a single species in a single patient. Three hundred and forty-five single species events (619 total blood culture isolates) were noted in 240 burned patients. The five most common species noted were coagulase negative *Staphylococcus*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Acinetobacter calcoaceticus-baumannii* complex. Only four isolates were obligate anaerobic bacteria, all *Propionibacterium acnes* from four separate patients (Table 1). None of these four patients had a second blood culture with growth of *P. acnes* nor did they have a clinical course consistent with *P. acnes* infection. Growth in anaerobic versus aerobic culture was recorded in 310 of 619 (50.1%) burned patient blood culture sets with growth. Of culture sets where anaerobic or aerobic growth was noted, 46 (13.5%) of organisms were identified from solely the anaerobic culture bottle. Eight of these 46 organisms were identified in a separate aerobic blood culture within 48 h.

**Table 1 – Top 17 blood culture results in burned patients**

Isolate	Single species events (% total)	Total positive cultures (% total)	# cultures with known aerobic vs. anaerobic bottle growth	# cultures with only anaerobic bottle growth (% total known)
<b>Aerobic bacteria</b>				
Coagulase negative staphylococci	69 (20.0)	88 (14.2)	30	10 (33.3)
<i>Staphylococcus aureus</i>	47 (13.6)	82 (13.3)	22	7 (32.0)
<i>Klebsiella pneumoniae</i>	39 (11.3)	82 (13.3)	44	5 (11.4)
<i>Pseudomonas aeruginosa</i>	29 (8.4)	135 (21.8)	80	5 (6.3)
<i>Acinetobacter calcoaceticus-baumannii</i> complex	29 (8.4)	46 (7.4)	34	3 (9.0)
<i>Escherichia coli</i>	14 (4.1)	17 (2.8)	–	–
<i>Enterobacter cloacae</i>	13 (3.8)	24 (3.9)	18	2 (11.1)
<i>Enterobacter aerogenes</i>	13 (3.8)	18 (2.9)	–	–
<i>Serratia marsescens</i>	12 (3.5)	25 (4.0)	11	1 (9.1)
<i>Streptococcus viridans</i> group	10 (2.9)	12 (1.9)	5	1 (20.0)
<i>Proteus mirabilis</i>	7 (2.0)	7 (1.1)	4	1 (25.0)
<i>Streptococcus</i> group D	7 (2.0)	7 (1.1)	2	1 (50.0)
<i>Enterococcus</i> spp.	6 (1.7)	15 (2.4)	8	2 (25.0)
<i>Bacillus</i> sp. (not anthracis)	6 (1.7)	6 (1.0)	4	2 (50.0)
<b>Anaerobic bacteria</b>				
<i>Propionibacterium acnes</i>	4 (1.2)	4 (0.7)	4	4 (100)
<b>Fungi</b>				
<i>Candida albicans</i>	8 (2.3)	10 (1.6)	7	1 (14.3)
<i>Candida parapsilosis</i>	6 (1.7)	11 (1.8)	–	–

#### 4. Comment

Our study objective was to investigate the utility of anaerobic blood cultures in burned patients. We found no clinically significant cases of anaerobic bacteremia in the burned patients. This implies that, in the modern era, severe burn alone may not be associated with anaerobic bacteremia to any clinical extent. However, we did find a significant proportion of clinically significant non-anaerobic organisms that were cultured only from anaerobic media, and would have gone unnoticed if anaerobic culture were not performed.

Being at high risk for sepsis, infection remains the major cause of death among burned patients after the resuscitation phase [22,23]. In addition to other sites of infection, burn wounds have been established as a source of systemic bacteremia [19,23,24]. The devitalized, denatured, and moist wound environment favors the colonization and proliferation of a variety of organisms. A multitude of publications describe the frequent isolation of anaerobes in or on burn wounds, however, the reliability of these reports, is the subject of skepticism [15-19,21,25,26]. Many studies detailing wound cultures actually describe surface swabs of wounds, a method and microenvironment that do not engender the cultivation of anaerobic bacteria. Moreover, many wound culture publications fail to describe patient burn wound management, a critical element in determining the nature of patient infection, and one that may influence the isolation of anaerobes from wounds or blood. In contrast to the multitude of anaerobes documented in burn wounds, notations of anaerobic bacteremia are rare. A 1984 review of the literature, with the earliest citation dating back to 1942, mentions only four published cases of anaerobic bacteremia in 251 documented burned patients, two being *Clostridium* spp., one *B. fragilis*, and one *Peptococcus asaccharolyticus* [26]. A review of eight more recent studies, documenting a total of 397 burned patients with blood cultures, revealed only one, a 1985 study from China, that described anaerobes from blood culture (2 of 10 patients) [16,21,22,24,27-30].

Although some authors feel there is no adequate algorithm for selective anaerobic blood culturing, burned patients may actually represent an ideal population for such a methodology. Outside of burn, traditional clinical risk factors for anaerobic infection are uncommon or obvious, thus mandating appropriate empiric antibiotic coverage. Although the clinical prediction of bacteremia is challenging in burned patients, it could be argued that in a cohort similar to ours, with a low to non-existent occurrence of clinically significant anaerobic bacteremia, very few, if any, cases of anaerobic bacteremia would be missed with a selective blood culture system using our current treatment strategies [31,32]. The benefits of a selective culture system could include fewer patient blood draws, decreased cost of culture materials, decreased demand for lab manpower assets, and increased blood culture sensitivity, if these resources were allocated to alternate culture media, such as fungal or additional aerobic culture bottles.

At variance with the above argument, our study found a number of clinically significant non-anaerobe bacteria were grown in solely anaerobic media, and thus would have been missed without dedicated anaerobic cultures. This is

consistent with past studies that described the growth of bacteria other than obligate anaerobes in anaerobic culture due to the facultative nature of some pathogens [33-36]. In addition, anaerobic culture systems have also been able to detect aerobic pathogens not recovered by aerobic culture systems despite standardization of techniques, blood inoculation into the bottle and other factors that might effect the yield of bacteria [36,37]. Unfortunately, as we were unable to determine aerobic versus anaerobic bottle growth for approximately half of our isolates, a quantitative estimate of the clinical impact for these organisms cannot be made, but would likely be deleterious.

There are a number of limitations to our study. First, the study is retrospective in design, and a prospective design would offer more exact conclusions. Next, given that our data originates from an electronic database, there is the possibility of misidentified culture data or systematic error in our search that could influence the accuracy of our results. Additionally, our report is limited by the original data entered into our database; for example, we could not identify anaerobic versus aerobic culture media growth for nearly half our isolates because it was not entered. This type of limitation also led to the fact that we could only tabulate single species events, rather than identify separate infections with the same species in any one patient (i.e. single culture isolates).

Anticipation of anaerobic infection, increased use of antimicrobials possessing anaerobic activity, changing patient populations, and empiric perioperative antibiotics have all been postulated as reasons for declining anaerobic bacteremia in other populations, and, in addition to advances in burn care, may also be impacting the burned patient population [12]. This study suggests that clinically significant anaerobic bacteria do not appear to be major contributors to bacteremia in burned patients. However, the ability of anaerobic blood cultures to also detect organisms other than obligate anaerobes should give pause for thought before withdrawal of routine anaerobic culture in burned patients. In light of our findings, further prospective analysis would be warranted before such a measure could be implemented.

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